Composter Assist Technology for Students with Autism Spectrum Disorder: Environmentally-Friendly Behavior

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Abstract
Indonesia is currently facing a serious problems of waste management, it will generate 31,950,444.04 tons of waste in 2023 and students' behavior plays a key role to behave environmentally friendly. This study examines the composter as an assistive technology to promote environmentally friendly behavior (EFB) students with autism spectrum disorder (ASD). The Method used was an ethnographic case study design with semi-structured interviews and direct observation of the composting process. The results showed that the composter is used as an assistive technology for teaching agricultural vocational subjects in students with ASD to promote anti-littering behavior and foster the discipline of waste sorting. It also helps to reduce waste generation and pollution in schools. The conclusion is that the composter as an assistive technology for students with ASD, can be useful in implementing environmental education to prevent environmental damage caused by habituation to EFBs. The implication of the study can be used to improve the pro-environmentally behavior of students with disabilities and encourage them to adopt sustainable waste management by balancing social, environmentally, and economically issues.
Keywords: Composter, Environmental, Waste, Behavior, ASD

1. INTRODUCTION

In Indonesia, people's behavior is closely related to waste generation, the amount of waste was 37,833,067.09 tons in 2022 and 31,950,444.04 tons in 2023 [1]. Although the Ministry of Environment and Forestry has made efforts to prevent the reduction of waste volume through various programs, the reduction in waste volume is not very noticeable. This explains why waste management implementation in

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Indonesia is still poor. Waste management programs are implemented by the government in both schools and society, specifically waste bank, composting, TPS3R, TPST [1]. On the regulatory side, Indonesia has issued Regulation No. 18 of 2008 on waste management; Government Regulation No. 81 of 2012 on the treatment of household waste and similar household waste; Presidential Decree No. 97 of 2017 on national guidelines and strategies for the treatment household waste and similar household waste;; Regulation Minister of Environment No. 13 of 2012 on guidelines for the implementation of reduce, reuse and recycle by waste bank; and Regulation Minister of Environment and Forestry No. 53 of 2019 on the award of Adiwiyata school. If citizens follow EFB rules, waste management programs and policies can successfully reduce the amount of waste. One of way to change local residents' behavior toward environmental protection and promote EFB can be achieved through education[2][3][4].

The main source of school waste generation is students. In almost all primary and secondary schools across Indonesia, student waste mainly consists food. The number of students in Indonesia for the current 2023/2024 school year is 52.923 million, and almost 50% of this number, or 24.007 million, will students of primary school. There are 9.911 million junior high school students and 5.271 million high school students in Indonesia, which is about 19% of the total population of Indonesia [5]. With a large number of students, the amount of waste generated is also very large. Several studies have been conducted to analyse the profile of waste generation in school [6][7], and the results show that each individual in school generates about 0.05 to 0.15 kg of waste daily.

Designing a composting method tailored to schools can minimize solid waste litter, improve sanitation, and protect the environment for future generations. The successfully achieve its goals, sustainable waste management must take into account cultural, social and economic aspects. Otherwise, it is likely to fail [8]. This article aims to explain how composter can be used as an assistive technology to promote waste reduction and EFB in schools students with ASD. The results are intended to serve as inspiration schools to encourage students to play their role in sustainable waste management. According to [9], effective solid waste management practices in schools can lead to a more sustainable future by reducing waste and promoting recycling and composting. In addition, teaching waste management knowledge can make students understand the importance of environmental conservation. Several studies have highlighted the benefits of implementing solid waste management programs in schools. For example, [10] found in their study that implementing a waste management programs in schools not only reduces waste generation but also leads to a reduction in greenhouse gas emissions. Similarly, [11] found that implementing a solid waste management programs in schools led to a significantly reduced waste generation and improved the overall cleanliness of the school environment.

Schools and their surrounding areas should not be used as garbage dumps, as this may be a source of disease. Sustainable organic waste management is essential to combat the negative effects of organic waste and to maintain the school environment. The development of composting technologies is based on the natural decomposition process of organic matter. The decomposition process is optimized so that composting occurs more quickly and efficiently [12]. Moreover, most studies have been carried out under well-controlled experimental conditions in small scale pilot compost bins, but few in the field applications of household or other small scale composting systems [13][14][15]. Composting technology is very important today, to overcome the problem of organic waste, especially in solving the waste problem in schools and their surrounding areas. Home composting offers great potential for the sustainable management of organic waste generated in the homes, gardens and vegetable plots [16]. The introduction of home composting has been promoted very intensively in recent years in several Spanish regions, such as Galiza, Basque Country, Navarre, Catalonia and others [14]. Composting school waste in drum rotary composters of appropriate capacity allows for sustainable decentralized waste management of organic waste at source at a relatively low cost, bringing multiple benefits to society [17]. The composter serves as an assistive technology to support teaching and learning of students with ASD to practice composting by collecting schoolyard waste, separating it, shredding it into 2 cm pieces, weighing it, placing it in the composter, and covering it with a layer of compost. The term autism spectrum disorder is used to describe individuals who have demonstrated specific repetitive behaviours, significantly restricted interests and/or sensory behaviours, social communication problems since early childhood. According to the latest estimates from the CDC, approximately 1 in 36 children is diagnosed with ASD, and data suggest that the incidence is four times higher in boy. The prevalence in Greece among children aged 10 to 11 years is reported to be 1,15% [18]. Assistive technology tools offer new opportunities for therapeutic approach designed to improve a range of skills that have a significant impact on the well-being of children with ASD contribute to the integration of these children into society [19]. People with disabilities are disproportionately affected by environmental issues, as noted in the 2018 United Nations flagship report on disability and development, “Achieving the sustainable development goals by, for and with people with disabilities” [20], and in environmentalism to coverage of disable people in focus on environmental education [21]. One of the EFBs implemented at the special school C Autism Tuban, Indonesia participating in the Adiwiyata program is waste management. Seventh, eighth and ninth grade students with intellectual disabilities, Down syndrome and ASD participated in the study.

EFB involves and engages individuals with extensive environmental knowledge. Effective environmental education aims to improve environmental attitudes, knowledge, and skills [22]. Therefore, to improve EFB is essential that policymaker,

educators, and others stakeholders understand the importance of education on EFB. Strengthening environmental knowledge and skills is important for the younger generation [23]. If EFB is not taught from an early age, it will have a greater impact on environmental issues [24], such as current environmental problem, such as the waste problem. It is very important to pay attention to and analyze the several studies on organic waste disposal in schools, as it has a negative impact on the environment and students' health.

Proper management of household waste helps to reduce these negative impacts and promote sustainable living [25]. Household scale organic waste processing using simple technologies in closed system is effective, beginning with disciplined behavior to separate organic waste consisting of food scraps, agricultural waste, and so on which can be processed into compost through the composting process. This composting process produces organic fertilizer that can be used to improve soil quality and promote plant growth. All food waste generates in schools can be recycled on-site after disposal. Several studies have shown how EFBs can be improved in schools and the limitations of their implementation in special schools for students with disabilities, including students with ASD. Similarly, there are not many studies on the implementation of composters, a simple technology used in the teaching and learning process of composting for students, including students with ASD. The study describes the use of composting equipment of drum home composter as an assistive technology in students with ASD to improve knowledge of recognizing organic waste to be used as recycling raw material for compost production. The presence of DHCs as an assistive technology in the teaching and learning process in students with ASD allows students to not litter, to act cooperate, follow instructions in separating waste, and improve their skills in cutting, weighing, and measuring.

2. METHODS

2.1 Materials

Drum Home Composter (DHC) of 200 L capacity was used for the study (figure 1). The composting system consist high density polyethylene (HDPE) cylindrical drum with lid, which can be tied tightly to prevent rainwater and rodents from entering. The DHC is equipped with a filter made of stainless steel with a diameter of 40 cm which is installed at a distance of 20 cm from the bottom to facilitate excess leachate during the composting process. Diagonal aeration holes were installed using Polyvinyl chloride pipe of 32 mm in diameter to ensure the composting process was aerobic. The drum was stirred manually to provide appropriate mixing and aeration of the feedstock during composting.

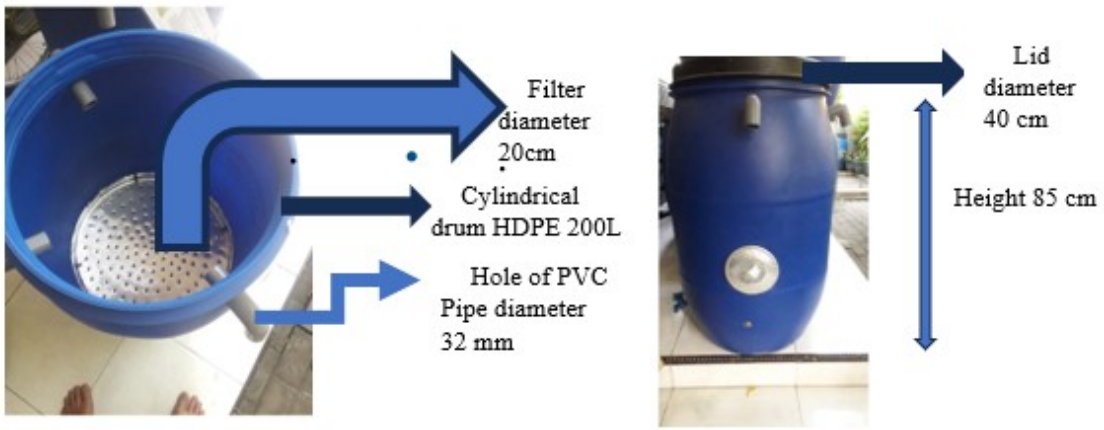

Figure 1. Drum Home Composter as Assistive Technology of Students with ASD

The composting steps from taking and sorting of organic waste in the school environment. Compost production process is conducted by students with ASD through teaching and learning agriculture vocational grade 8th and 12th on a scheduled basis, namely: (1) Garbage collection from classrooms, offices, canteen, school garbage cans, and schoolyard; (2) Waste separation at composting area (teachers and students); (3) Garbage Stashing at the compost area (teachers and students); (4) put feedstock to composter (DHC); (5) Pour compost on top layer; (6) stirred manually to provide appropriate mixing and aeration of the feedstock during composting (compost area); (7) Spray water to add humidity

2.2 Participant

This study selected participants purposively is student with ASD, which enroll agriculture vocational instruction in state of special school C Autism Tuban, East Java, Indonesia. The participants in the study were 4 students (MR, MU, AM, IPS) who recently in middle and high school (8 to 12). In order that eligible to attend special schools for students with disabilities, students must be formally diagnosed with autism (demonstration school profile in website). Students must implement environmental care and cultural movements by participating in the Adiwiyata school program to assist in the development of personal life and learning strategies (demonstration school website). The focus of this study accepts students in Grades 8 to 12, and these students range from 15 to 20 years of age when they are accepted into the program. This school follows “merdeka curriculum within a highly individualized setting, with class sizes ranging from five to eight students.

2.3 Design research

This research is qualitative using an ethnographic case study design. It is said to be case study ethnography, because in this design, the researcher focuses on a program, event, or action involving individuals, not the group itself (Stake, 1995 in [26]. In addition, when authors research a group, they may be more interested in describing the group's activities than in identifying common behavioral patterns exhibited by the group [26]. Yin (1989) developed qualitative case studies with

quantitative evidence. Merriam (1988) supports qualitative case study approach in the field of education. The study begins with the "students with ASD" profile, then continues with the theoretical basis for the study which is "framed" in an interactive theory. The study continues by looking at teachers' perspectives on learning services students with ASD in the classroom to predict teacher failure and success in implementing teaching and learning composting process used drum home composter (DHC) as assistive technology for students with ASD. Then the study continues with exploration EFB students with ASD through Agriculture vocational instruction to produce compost use assistive technology DHC.

According to Creswell, in qualitative case studies, one can structure questions or sub-questions through issues in the theme being explored, and these sub-questions can also include steps in data collection procedures, analysis and narrative format construction. Sub questions to explore EFB of students with ASD to conducting case study research are as follows: (1) Do students with ASD bring food and drink or tumbler from home; (2) Do the students with ASD always finish their food; (3) Do students with ASD throw; (4) Do students with ASD put food waste in the garbage bin; (5) Do students with ASD behave separating waste into organic and inorganic waste.

3. RESULTS AND DISCUSSION

3.1 Drum Home Composter (DHC) as assistive technology

Learning about composting schoolyard waste is integrated into intra curricular activities in the Agricultural Vocational Skills subject. Activities are held twice a month every Tuesday for 2 hours of lessons on Agricultural Vocational Skills which are carried out jointly by students from class 8 of Junior high special school to class 12 of Senior high special school. Implementation of hands-on learning use DHC as assistive technology begins with modeling with the help of physical and verbal prompts to prepare tools and materials including how to prepare raw materials from schoolyard waste. The teacher demonstrates the tools needed to prepare the raw materials for making compost, then the Student with ASD students imitate and practice taking the tools needed. Assistive technology can enhance and help students with ASD increase their acquisition of knowledge and skills in the classroom [27]. The successful use of assistive technology in the teaching and learning process is very dependent on the teacher's ability and mastery [28]. The teacher gives examples of backyard waste that can be used as raw materials. Students practice by picking up schoolyard waste, both dry and fresh, with a composition according to the C/N ratio.

The next step is that the teacher divides the tasks into small teams for each section, namely the Chopper Team, the Weighing Team, the Mixing Team, and the Composting Team. Four students with ASD divided into students with intellectual disability group. The distribution of students in each team is adjusted to the abilities

of each student. In carrying out the production, each team is accompanied by a class teacher who has been assigned previously. Each student works according to their assigned assignment. School garden waste consists of leaves, flowers and fruit that have fallen and fallen in the yard around the school. This waste is collected from school cleaning staff every day and is the result of the community service of all school residents. Schoolyard waste that is composted includes leaves, flowers and fruit that have fallen to the ground or those that have been cut down to tidy up the plants. Data on student engagement in the implementation of hands-on learning is presented in the following table. Finding form this study show that students with ASD tend to have difficulty focusing on teachers unless visual distraction are minimized [29]; visual-tactile simultaneous for students with ASD [30]. Students with ASD cannot divide their focus between paying attention to the teacher or watching the video [31]; several studies suggest that reducing signal vision, hearing, and touch will reduce multisensory students with ASD [32][33][34].

Table 1. Data Cognitive dan Skill Engagement Used DHC

Initial Name	Grade	Type of Disabilities	Cognitive Engagement	Skill Engagement
IPS	8th	ASD	1. Understand commands 2. Able to maintain focus but short span and easily distract 3. Able carry out instruction independently 4. Oral communication	1. Able to chop feedstock 2. Able to weigh raw materials 3. Able to sprinkle compost on the top layer of feedstock waste
AM	9th	ASD	1. Understand commands 2. Able to maintain focus 3. Able to carry out instruction with verbal prompt 4. Oral communication	1. Able to chop feedstock 2. Able to weigh raw materials
MU	10th	ASD	1. Understand commands 2. Able to maintain focus but short span and easily distract 3. Able to carry out instruction with	1. Able to chop feedstock 2. Able to weigh raw materials

			verbal prompt 4. Oral communication	
MR	12th	ASD	1. Not being able to understand commands 2. Not able to maintain focus 3. Able to carry out instruction with verbal prompt 4. Oral communication	1. Able to sprinkle compost on the top layer of feedstock waste

3.2 Environmentally Friendly Behavior

The result of direct observation and interviews as a school that received the provincial level Adiwiyata school award is (1) students with ASD always bring tumbler dan packed lunch from home, (2) always finish eating, (3) don't consume food wrapped plastic (4) and don't consume that contain additive, (5) instruction teaching and learning used DHC as assistive technology to students with ASD built EFB by always placing leftover food in the garbage bin and no longer throwing it away in schoolyard. Behavior that has also become a habit is sorting waste according to type by placing it in the rubbish bin provided. Teacher always reminder not to throw away leftover food in the schoolyard but to process it used DHC to produce organic fertilizer. Students with ASD has also been able to remind his friends who throwing waste and have placed the wrong type of waste. Efficient school waste management can improve sanitation, enhance access to education, and facilitating effective teaching and learning [9]. Becoming a green school means taking action by introducing and strengthening conservation concept that creates a healthy learning environment [35]. Giving students with a supportive environmental infrastructure to take action is critical to sustaining it changes in the future [36]. Education plays an important role in encounter EFB for environmental sustainability [37].

4. CONCLUSION

The conclusions implementation DHC as an assistive technology will help advance EFB in students with ASD to drive AFB. Through composting will help students with ASD remember what organic waste is, how to separate waste, learn more enthusiastically, understand the composting process, become more proficient in DHC, promote a visual learning style, and help green improve their school. Challenges experienced in practice depend on the sustainability feedstock waste and teachers' competence in waste management, including the equipment used to shred raw material waste. The limitation of this study be located in the number of participants and the focus of the topic. The generalizability of this study may not

apply because there was only four participants student with ASD and from one special need school. Also, this topic is only a small part of environmental education and may not apply to other learning environment topics in science education. Further research could focus on other topics, namely the introduction assistive technology in the environment to enhance the inclusion of other types of disabilities, such as hearing impairment, learning disabilities and intellectual disabilities. This is important because some special schools and inclusive school also have a high number of these students.

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